G. A. O'Donnell. S.J.
S.J. B

A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

For Private Circulation

LOYOLA COLLEGE
BALTIMORE, MARYLAND

VOL. XII DECEMBER, 1934 NO. 2

A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

For Private Circulation

LOYOLA COLLEGE
BALTIMORE, MARYLAND

VOL. XII DECEMBER, 1934 NO. 2

CONTENTS

Bulletin of American Association of Jesuit Scientists
EASTERN STATES DIVISION

Vol. XII DECEMBER, 1934 No. 2

EDITORIAL

THE ULTIMATE CONSTITUTION OF MATTER

New types of fundamental building stones for constructing atoms are being required by scientists and are being given a hypothetical existence in order to explain their experimental results that cannot be explained with the varied assortment now available. They have: the negatron or electron, negatively charged; the positron or proton, positively charged; and the neutron or the compound unit, consisting of a proton and a negatron in intimate contact.

It is suggested by Dr. Tolansky, of the astro physics department of the Imperial College of Science, London, that there exists a second kind of a neutron and that this would consist of a positron in intimate contact with a negative proton. The negative proton proposed is as yet hypothetical, as is the new kind of neutron. Their existence is based largely on analogy and on difficulties in explaining nuclear phenomena. The negative proton proposed would be the counterpart of the positively charged proton whose

existence is now generally conceded, just as the recently discovered positron is the oppositely charged counterpart of the electron.

Dr. Tolansky assumes that the negative proton only exists in a bound state in the nucleus. It would be difficult to identify either type of neutron in experiments now being made in which the atom is disrupted by bombardment, as they present no external difference and the internal difference is due to the relative orientation of the masses of their component units and the magnetic fields which neutralize each other.

The trend of atomic theories and the structure of the atoms and molecules, in recent years, has been more and more mathematical. Where once atom models, like the solar system atom of Bohr, offered the scientists a representation in discussing atoms among themselves, the recent development has been in the other direction. Among the younger school of brilliant mathematical physicists there is a strong belief that one should not try to picture what an atom is like and that mechanical atom models are inadequate. To the older school of scientists the abandonment of the atom models has been a source of regret. While content to let the younger men advance with abstract mathematics, the conservative school find themselves somewhat baffled.

At the same time, there are many scientists, not necessarily classed as "older" scientists, who feel that everything that is new in the way of the theories is not perfect. There are many who find in the old something of merit that need not, or should not, be ruthlessly thrown overboard in the name of progress.

Among other physical concepts that are at present outmoded, in the most orthodox circles, is the ether. The hypothetical substance which filled all space and served as the medium by which light and electromagnetic waves were transmitted between two distant points in the universe. Light and every other type of wave motion must have substance to carry it. This theory was cast aside for a number of reasons. It could not be detected in the experiments of Michelson and Morley; then too, it had to be so fluid that it could penetrate the interstices between the atoms in solids, and yet, at the same time had to have nearly perfect elasticity to transmit light rays with a velocity of 186,000 miles a second.

Dr. Dayton C. Miller, head of the Department of Physics at the Case School of Applied Science, started working on the ether-drift experiment thirty years ago. He believes there is an ether, and has a great collection of data to prove his point. Professor Michelson, Nobel Prize winner and until his recent death, the dean of American scientists, failed to find the effect of an ether drag and hence the reality of its existence. Dr. Miller has so improved Michelson's work and increased a thousand fold the mass of data on the problem that there are many who think he is right or at least, that there is a reasonable doubt for the case.

Assuming that there is an ether, one can conceive a theory of matter and atoms which has many plausible points, some of which are born out in the discoveries of the position of Dr. Carl D. Anderson. The theory states that while the central core of an atom of hydrogen is the proton, the elec-

trical opposite of an electron, the proton is considered as the smallest aggregate of positive particles, that could just equalize the electrical charge of an electron, but however not the ultimate unit. When the proton aggregate of particles was liberated the little positive parts spread out and filled space. The composite parts of the proton were defined as "matrons", and the substance which filled space was the ether or non atomic matter.

Radiation has a dual nature: the gamma rays given off by disintegrating radium, have been found to behave sometimes like true waves and sometimes like particles, with properties of impact. The dual nature is due to the fact that when a proton is shattered the matrons in it fly in all directions, penetrating the interstices of matter to great depth. In this phase gamma rays are small particles in motion. The disruption of the proton also sets up a disturbance in the surrounding ether and so sets up an electromagnetic wave which also passes through solid substance, because the ether fills all the interstices of the substance.

Matrons and positrons both have a positive charge upon them; both probably have the weight of an electron. The proton is the equivalent of an electron in electrical energy, but has 1850 times as much mass. To postulate the existence of some electrical sub unit of a proton helps to explain the existence of isotopes.

Physically and mathematically there is still more to be explained; new facts bring new evidence of the ultimate constitution of matter, but we are far from the solution of the complex problem.

R. B. S.

THE RELATION OF SCIENCE AND PHILOSOPHY

Rev. Joseph P. Kelly, S.J.

To say that the problems of the relations of science and philosophy occupies a foremost place in modern thought, is merely to state a truism. Our scientific and philosophical periodicals contain lengthy discussion of this question. Even in text books, treating strictly scientific theories, do we find the authors pausing to explain their philosophy or suggesting the philosophical import of some scientific discovery. As, for example, Dr. Robert Millikan, after some discussion of the Atomic Theory of Democritus, concludes that "today, there is absolutely no philosophy in the field other than the atomic philosophy, at least among the physicists". (1). There is no doubt that the rapid advances of science and new discoveries have placed the natural sciences in a very favorable light. Science, to the "every-day man" is represented by the radio, the aeroplane, and the innumerable household comforts that it has brought within his reach. The practical applications of scientific theories have a strong appeal to him and tend to confirm him in the popular notion that Science is the oracle of knowledge. I imagine that such a man would be somewhat confused if he attempted to explain what he meant by science or to tell us whence science derives its authority to say the last word on any subject. This admiration is not confined to the man of the street. Among the educated classes there is a genuine appreciation of the intellectual genius manifested in the theoretical construction of the principles of science. The theory of relativity, the quantum theory and wave mechanics, to mention only a few, are accomplishments of decided merit and deserve our unstinted praise. Philosophy, on the other hand, can offer no such imposing display. The different systems of philosophy, whose fundamentals are often contradictory, are apt to leave the student of philosophy in a state of mental confusion. "The apparent unity of scientific speculation serves only to throw into bolder relief the opposing claims of philosophers". Outside the system of Scholastic Philosophy, there is scarcely any other that is knit together in a coherent unity. Hence, many deride the study of philosophy or reject it as worthless. It is the opinion of a considerable number of men of science that philosophy leads us to

(1). "The Electron." Millikan. p. 10.
Also, "Atomic Physics," Physics Staff of U. of Pittsburgh. p. 320.
"Introduction to Physical Science. Miller. p. 361.
"Where is Science Going?" Planck. p. 144.

a maze of unprofitable speculation. Because of this unsatisfactory state of philosophy, there is a notion prevalent in some quarters that philosophy, if it is to become progressive, must turn to the sciences. It must seek its inspiration in the natural sciences. This will not mean merely to base its reflection on the data of science but the adoption of the methods of science. It must in reality, become science. "It is a tempting suggestion. We hardly know how to resist it because the spell of science is upon us all." (2). That many have already yielded to this alluring temptation, is evident from modern literature on the relations of science and philosophy. No doubt the intention is very laudable; these men are inspired with the desire of claiming for the subject, the name and the reputation of a science and with the hope that the progress of philosophy will compare favorably with that of the physical sciences. But the attempt will prove suicidal, for it will destroy philosophy by depriving it of its natural aims and functions.

This attitude reflects the mentality of the past century. It is the position of those who would restrict the use of the term "science" to knowledge gained through experience. It supposes that experience is the only safe criterion of knowledge and that in this way alone can we acquire positive knowledge. "The only authority for science must be the observed facts and the rational interpretation of observed facts. In the positivism of the eighteenth century this tendency reached its extreme form in the demand that science should shun philosophical as well as theological authority, should shun, in fact, theoretical speculation altogether and confine itself to the description of actual observations". (3). Out of this attitude grew the notion of the absolute separation of science and philosophy. It is present in our modern science, as may be seen from the interpretation of the "Operational Method" which is commonly accepted in science today. "....the operational point of view involves much more than a mere restriction of the sense in which we understand 'concept', but means a far-reaching change in all our habits of thought, in that we shall no longer permit ourselves to use as tools in our thinking, concepts of which we cannot give an adequate account in terms of operation." (4). While this point of view may serve the scientist in his investigations, it is certainly an illegitimate extrapolation to assert that it is the only method to be used in the acquiring of human knowledge. Philosophy, if it is to be a philosophy, cannot be restricted to the field of physical operations. It leads to a distinction between science and philosophy that cannot be justified. For the distinction falls not only on the aims and the purpose of the two disciplines but also on the nature and the validity of rational cognition. Many scientists believe that science and philosophy should be kept clearly apart because they think that philosophical discussions will cloud the issues of natural science. "The leaders of physical science do not underrate the the importance of

(2). "Studies in Contemporary Metaphysics". Hoernle. p. 29.
(3). "Essentials of Scientific Method." Wolfe. p. 119.
(4). "Logic of Modern Physics". Bridgman. p. 31.

philosophy as a human interest but they account its value, so far as their resources are concerned, as indirect. It may give vigor to the mind; it can never give that command of the resources of the world which science makes its primary consideration......'Physics beware of metaphysics', is a maxim of science and in the last century, the golden age of scientific expansion, it was claimed for science that it was marked out by the positivity of its knowledge from the negativity of metaphysics, which was considered to be unsubstantial speculation''. (5). The underlying assumptions of these claims for science suppose that knowledge is concerned only ''with the command of the resources of the world'' and that scientific knowledge alone can be positive knowledge. Both science and philosophy seek to reveal the truth of the same material world, the relations of various corporal bodies and the properties that belong to them. It is not only in the sciences that we find positive knowledge; philosophy has a positive method of its own and through it we derive positive knowledge about the universe, unless we suppose that knowledge, which comes from experience, exhausts the field of positive cognition. This supposition cannot be proved. Let us consider the problem in the concrete. When we study a problem from the point of view of the physical sciences, e. g. gravitation, we are limited in our investigations by the very scope of the sciences. Science tries to explain all gravitational phenomena in terms of material particles, natural forces and natural causation. The force of attraction that is predicated of all bodies is expressed in a formula or formulas from which we may find the measure of this attraction. Laws are formulated to describe the mode of action of these bodies. Science is content to discover a working knowledge of material bodies and to explain them on a basis of natural causes. But these explanations remain within the bounds of nature. Beyond these limits there is a vast field of knowledge open to the mind. We cannot avoid the eternal ''why'' of things. Why do they exist? Whence do they come? Why have corporal beings the power of attracting one another? These questions bring us face to face with problems for which science has no answer. One might say that they deal with things that are beyond nature; that they are not subject to experience and therefore have no place in science. We would readily grant that but does it close the door to knowledge from other sources? To say that experience is the sole source of knowledge is simply to deny to the intellect of man its natural capacity and its legitimate activity. We do not mean to say that experimental knowledge is not true knowledge or that science may not justify itself in its self-imposed limitations. Since science ''ex professo'' limits itself to natural beings and natural causation, it is clear that the origin of bodies as well as the source of their potencies must be ascribed to something outside the bounds of nature. For science assumes as a starting point, the existence of the material world and proposes as its aim to describe the properties of bodies, to measure their activity and to formulate laws of their manner

(5). "The Scientific Approach to Philosophy". Carr. p. 1.

of action. On this assumption, there is no rational explanation of the ultimate cause of things and their actions unless we transcend the bounds of nature and have recourse to a supramundane cause. Hence it follows that if our search for knowledge we find facts and realities which transcend experience, we must look to another order than the physical for their explanation. This order will be the metaphysical or the metempirical.

It is this consideration of the relatively unlimited capacity of the human mind and the necessarily limited field of the natural sciences that compels us to investigate realities that are above the physical, if our knowledge is to be such as to satisfy the natural capacity of the intellect. If a physical being comes into existence, we rightly suppose, on the principle of causality, that another being has brought it into existence. If, however, we are dealing with material beings in the first moment of their existence, we must look for their cause outside the physical order. No created being is necessary.

Questions such as these show the need and the use of metaphysics in problems that have a bearing on science and philosophy, if our knowledge is to be proportioned to the natural capacity of the intellect. We must seek as far as possible the "Why" of things. Formerly this was the aim of the natural sciences, to investigate the "why" of things; the reason why things were as they were and why they acted as they did. But this purpose of science has undergone a change. The object of science is to study "cold facts" in their physical aspects and to formulate laws of their activity. "Physics is essentially a system of explanations of the behavior of things but our answers and explanations will rarely be of an ultimate nature." (6). "Science, it is maintained seeks only to discover what attributes things have and *how* they happen, not *why*, that is for what purpose things are as they are or events happen as they happen. If the term 'description' be used for any account of what things are like or how things happen, then, science may be said to be concerned with description." (7).

Philosophy, however, goes much deeper than this. It seeks to find those more general principles and reasons which will explain the intimate nature of things as they appear to us. It tries to acquire knowledge of physical realities and facts not merely through efficient causes or descriptions of their actions but by the four causes of things, the final as well as the efficient, the material cause and the formal. It is synthetic as well as analytic, synthetic in the fullest sense of the word, comprehending nature according to the capacity of the human mind. The philosopher is not satisfied with the proximate causes but delves deeper and deeper until he arrives at the ultimate causes. The philosopher may begin with those concrete facts which belong to the province of the natural sciences and agree with the conclusions of the sciences but he does not rest with these conclusions. "When the Scholastics following the teachings of the Holy Fathers, everywhere taught throughout their anthropology

(6). "The New Physics." L. Poncaire.
(7). "Essentials of Scientific Method." Wolf. p. 117.

that the human understanding can only rise to the knowledge of immaterial things by the things of sense, they well understood that nothing could be more useful than to investigate carefully the secrets of nature and to be conversant, long and laboriously with the study of the physical sciences'' (8).

The neglect of the fundamental distiuction between the purpose of science and that of philosophy has led to many difficulties and misunderstandings on the part of both scientists and philosophers. There is certainly a difference between the two disciplines but not a separation. They are not mutually exclusive but rather complementary. It is characteristic of philosophy that it brings us a more comprehensive view of nature and a deeper insight into the nature of things. For there is an interrelatedness and a continuity of nature that carries us beyond the scope of the physical sciences. Thus science needs philosophy and philosophy needs science. Human knowledge demands the considerations of the philosopher as well as the experimental investigations of the scientist. Both philosophy and science have a great deal to contribute to an ultimate, synoptic view of the universe. Philosophy must become scientific in the sense that it should always be prepared to recognize and accept the proved results of science. For these results will form both a starting point and a test of the validity of metaphysical principles in their application to reality. But ''Philosophy, because of the innate limitations of science, must soar above the formulations presented to it by science. It must also return to these formulations in order to check the truth of its own thoughts and constructions. In both ways, therefore, science aids and controls philosophy, for first of all, it starts philosophy on the right road to truth and then calls her back to the road whenever, because of the hardihood of her speculations, she strays into the by-paths of error and falsehood.'' (9). But philosophy can never become scientific in the sense that it be a laboratory science or that its sources of knowledge be limited to the inductive method of science. For, if philosophy must stand or fall by an ''ad hoc'' experiment, it ceases to be a philosophy. Philosophy deals with principles and relations which are too universal and comprehensive to be brought under the head of a particular experiment. ''A theory of philosophy is rarely such that it can be proved or disproved by some action devised ad hoc.'' (10).

The proper approach to problems touching science and philosophy demands a sympathetic attitude of mind on both sides. Science and philosophy have a necessary and legitimate place in human knowledge. Both are supposedly seeking the truth of the same objective reality. Science, with the aid of experience and the inductive method, can arrive only at a limited goal; the limitations imposed by the scope of science prevent it from attaining ultimate truth. The philosopher whose object is to discover truth through ultimate causes, is able to carry on the work of

---

(8). "Aeterni Patris." Encyclical of Pope Leo XIII.
(9). "Scholasticism". DeWulf. p. 209.
(10). "Hoernle." op. cit. 49.

the scientist. Their purposes and aims are different but this difference does not prevent a closer approach to the final truth of reality. To limit knowledge to experience and to deny that the deductive method is legitimate is wrong; it is equally false to assert that the deductive and the a priori methods alone have value. A judicious application of the inductive and the deductive methods, of analysis and synthesis will perhaps lead to a "via media" that will be both useful and rational. Let us bear in mind the fundamental definition of philosophy and its real purpose; let us admit the distinction of the sciences and their particular purposes. If we maintain the legitimate scope of science and philosophy, each in its own field of work, we can be justified in our hope of progress. Perhaps we will be able to approach the ultimate aim of all investigation, the knowledge of reality, diverse and multiplied in the ever changing manifestations of concrete realities but ultimately radicated in ontological truth.

(Editor's Note. This is the first of a series of articles treating some general relations between Science and Philosophy. It is impossible, in the space of a few articles to offer an ultimate solution of this vast question. It is hoped that an exposition of some fundamental principles and notions will suggest a "modus operandi" to those who desire a closer union between Scholastic Philosophy and Science).

BIBLIOGRAPHY OF SCIENCE AND PHILOSOPHY

REV. JOHN S. O'CONOR, S.J.

Speaking of the philosophical advances in the "New Mathematics" during the nineteenth century Bertrand Russell, in his Skeptical Essays (P. 71) concludes as follows: "All these results were obtained by ordinary mathematical methods, and were as indubitable as the multiplication table. *Philosophers met the situation by not reading the authors concerned.*"

While we may not agree with his recent aberration in the field of the social sciences, there seems to be considerable justification for this particular charge of Russell, not only in the field of mathematics, but in that of physics as well.

We may perhaps excuse many in the past for their lack of familiarity with the works of Lobatchevski, Weierstrass and Cantor, because of their publication in organs not generally available, but the quantities of highly publicized books that have been coming out in all countries, and nearly every language make such excuses impossible to-day,—at least with the so-called "New Physics".

It was with a view to cooperating with the work of teaching "Scientific Questions connected with Philosophy" that the subjoined bibliography was begun.

The books therein contained might be divided roughly into five classes: 1st. Strictly scientific treatises such as Darrow's "Introduction to Contemporary Physics" which give at least in part the material on which the "New Physics", and "New Philosophy of Science" must be founded; 2d. Books like Soddy's "Interpretation of the Atom" which in addition to "the facts in the case" give a running commentary on their significance; 3d. The "Romantic School" of Jeans and Eddington; 4th. Books with ex professo attack the philosophical problems which arise out of the study of Physics, as N. R. Campbell's "Physics, The Elements"; 5th. Certain very specialized treatises, whose contents may be required for the elucidation of disputed points such as the phases of matter. Bridgman's "Physics of High Pressure", would be a good example of that class.

The list makes no attempt to be exhaustive, and includes only works which have been published in English.

It was suggested that the exceptionally good books be "starred", but since such classifications must be based on personal judgment, it was decided to submit the list without approval or condemnation of its contents, and reserve for perhaps a future issue of the BULLETIN, a "preferred list" with some review and criticism of the volumes demanding special attention.

The credit of checking publishers, dates, and of "alphabetizing" the list is due almost entirely to the cooperation of Mr. Walter J. Miller, S.J.

BIBLIOGRAPHY OF SCIENCE AND PHILOSOPHY

Adams, G. P., et al.	Causality Symposium, cf. Problem of Substance, Nature of Facts	Univ. of Cal. Pr.	1932
Alexander, S.	Space, Time and Deity	Macmillan	1920
Allen, H. S.	Electrons and Waves	Macmillan	1932
Andrade, E. N.	Structure of the Atom 3rd ed.	Harcourt Brace	1923
	The Mechanism of Nature	Bell, London	1932
Aston, F. W.	Mass Spectra and Isotopes	Arnold, London	1934
Barry, F.	Scientific Habit of Thought	Colum. U. Pr.	1927
Bavink, B.	Science and God	Reynal & Hitchcock	1934
	The Natural Sciences Ed. 4	Century	1932
	N.B. The Anatomy of Modern Science (Bell) is Engl. edit.		
Bird, J. M.	Einstein's Relativity and Gravitation	Scientific American	1921
Blackwood, O. H. & Staff of Physics Dep't., U. of Pittsburgh	Outline of Atomic Physics	Wiley	1933
Bohr, N.	Atomic Theory and Description of Nature	Cambridge	1934
Bolton, L.	Introduction to the Theory of Relativity	Dutton	1921
Bosanquet, B.	Science and Philosophy	Macmillan	1927
Bragg, W. H.	Concerning the Nature of Things	Harper	1925
	The Universe of Light	Macmillan	1933
Bragg, W. H. & W. L.	The Crystalline State	Bell, London	1934
Bridgman, P. W.	Physics of High Pressure	Macmillan	1931
	The Logic of Modern Physics	Macmillan	1927
Broad, C. D.	Mind and Its Place in Nature	Harc. Brace	1925
	Perception, Physics and Reality	Macmillan	1914
	Scientific Thought	Harc. Brace	1923
Burnham, J.&P. Wheelwright	Philosophical Analysis, Introduction to	Holt	1932
Burtt, E. A.	Metaphysical Foundations of Modern Physical Science	Kegan Paul, London	1932

Burtt, E. A.	Principles and Problems of Right Thinking	Harpers	1928
Cajori, F.	History of Physics	Macmillan	1899
California, Publications of the University of	Causality (symposium)	U. of Cal.	1932
Campbell, N. R.	Physics, The Elements	Cambridge Univ. Press	1920
	What Is Science?	Methuen	1921
Castelfranchi, G.	Recent Advances in Atomic Physics, 2 vols.	P. Blakiston Philadelphia	1932
Cohen, M.	Reason and Nature	Harc. Brace	1932
Cohen, M. & E. Nagel	Introduction to Logic and Scientific Method	Harc. Brace	1934
Condon, E. V. & P. M. Morse	Quantum Mechanics	McGraw-Hill	1931
Conger, G. P.	A World of Epitomization	Princeton U. P.	1931
Crew, H.	The Rise of Modern Physics	Williams & Wilkins	1928
Crowther, J. A.	Molecular Physics	P. Blakiston Philadelphia	1923
D'Abro, A.	The Evolution of Scientific Thought from Newton to Einstein	New York	1927
Dampier-Whetham, W. C.	History of Science and its Relations with Philosophy and Religion	Macmillan	1932
Dantzig, T.	Number The Language of Science	Macmillan	1930
Darrow, K. K.	Electrical Phenomena in Gases	Williams & Wilkins Baltimore	1933
	Introduction to Contemporary Physics	Van Nostrand	1927
	Monographs on Some Contemporary Advances in Physics, pub. by Bell Teleph. System		
Darwin, C. G.	New Conceptions of Matter	Macmillan	1931
DeBroglie, L.	Corpuscular Waves	Report, Smithsonian Institution	1930
	Wave Mechanics	Methuen	1931
Debye, P.	Polar Molecules	Chemical Cata. Co.	1929
Dewey, J. J. Ratner, ed.	Philosophy of John Dewey	Holt	1928
Dingle, H.	Science and Human Experience	Macmillan	1932

Dirac, P. A. M.	Principles of Quantum Mechanics	Oxford	1930
Dotterer, R. H.	Philosophy by Way of the Sciences	Macmillan	1929
Dyson, F. and others	Science, Today and To morrow (Lectures at Morley College)	Williams & Norgate, London	1932
Eddington, A. S	Science and the Unseen World	Macmillan	1929
	Space, Time and Gravitation	Cambridge U. P.	1921
	New Pathways in Science	Macmillan	1934
	The Expanding Universe	Macmillan	1933
	The Nature of the Physical World	Macmillan	1929
Einstein, A.	Relativity, The General and Special Theory, 10th ed.	Methuen, London	1931
Eldridge, J. A.	The Physical Basis of Things	McGraw Hill	1934
Fraser, R. G. J.	Molecular Rays	Cambridge	1931
Gamow, G.	Constitution of Atomic Nuclei & Radioactivity	Oxford Pr.	1931
Gerlach, W. & F. J. Fuchs	Matter, Electricity and Energy, 2nd ed.	Van Nostrand	1928
Gollancz, V. publish. (many authors)	Outline of Modern Knowledge Ed. William Rose	V. Gollancz London	1931
Gregory, J. C.	Short History of Atomism	Black, London	1931
Gunn, J. A.	The Problem of Time	London	1929
Haas, Arthur E.	Introduction to Theoretical Physics 2 vols. 4th ed. Germ.	Van Nostrand Constable, ed. 2	1928 9
	The New Physics	Dutton	1923
	The Atomic Theory, is Part III, Vol. 2 of Theor. Phys.		
	The World of Atoms	VanNostrand	1928
	Wave Mechanics and the New Quantum Theory	Van Nostrand Constable	1928 1928
Haldane, J. S.	The Sciences and Philosophy	Doubleday Doran	1930
Haldane, 21 others	Living Philosophies	Simon & Schuster	1931
Harnwell G. P. and J. J. Livingood	Experimental Atomic Physics	McGraw-Hill	1933

Havighurst, R. J.	Introduction to Physical Science	Edwards Bros.	
Heisenberg, W.	Physical Principles of the Quantum Theory	Chicago	1930
Huxley, J.	What Dare I Think?	London	1934
Huxley, T. H.	Method of Scientific Investigation, in his "Autobiography and Selected Essays"	Appleton Houghton Miff.	1911 1909
Jauncey, G. E.	Modern Physics	VanNostrand	1933
Jeans, J. H.	New Backgrounds of Science	Macmillan	1933
	The Mysterious Universe	Macmillan	1930
	The Universe Around Us	Macmillan	1929
Jevons, W. S.	Principles of Science	Macmillan	1883
Joad, C. E. M.	Philosophical Aspects of Modern Science	Allen & Unwin London	1932
Kelly, T. L.	Scientific Method	Macmillan	1932
Lenzen, V. F.	Nature of Physical Theory	Wiley	1931
Levy, H.	Universe of Science	Watts, London	1932
Lindemann, F. A.	Physical Signification of the Quantum Theory	Oxford	1932
Lodge, O. J.	Atoms and Rays	Doubleday Doran	1928
	Ether and Reality	Doubleday Doran	1925
	Pioneers of Science	Macmillan	1904
Loeb, L. B.	Nature of a Gas	Wiley	1931
	Kinetic Theory of Gasses	Wiley	1934
Loeb, L. B. and A. S. Adams	Development of Physical Thought	Wiley	1933
Luckiesh, M.	Foundations of the Universe	VanNostrand	1925
Mach, E.	The Science of Mechanics	Open Court	1893
MacKaye, J. J.	The Dynamic Universe	Scribner's	1931
Maréchal, J.	Studies in the Psychology of the Mystics (N. B. Cf. Sec. 1 for excellent treatment of scientific method.)	Burns Oates & Washbourne	1927
Maritain, J.	Introduction to Philosophy (Chaps. 5, 6, 8)	Sheed & Ward	1930
Miller, C.	Introduction to Physical Science (Chapt. XXXIII to end)	Wiley	1932
Millikan, R. A.	Science and the New Civilization	Scribner's	1930
	The Electron (2nd Revised Edition)	U. of Chicago P.	1934

Millikan, R. A.	Time, Matter and Values	U. of N. Car. P.	1932
More, L. T.	Limitations of Science	Holt	1915
Moreux, Abbe Theophile	Modern Science and the Truths Beyond	Browne & Nolan Lond. & Dublin	1931
Mott Smith, M. C.	This Mechanical World	Appleton	1931
Needham, J. (Ed.)	Science, Religion and Reality	Macmillan	1925
Newman, F. H.	Recent Advances in Physics (non-atomic)	P. Blakiston Philadelphia	1932
Northrop, F. S. C.	Science and First Principles	Macmillan	1931
Pauling, L. & S. Goudsmit	Structure of Line Spectra	McGraw-Hill	1931
Pearson, K.	Grammar of Science 3rd ed. rev.	A. & C. Black London	1911
Perrin, J.	Atoms	Constable, Lond.	1923
Pittsburgh, Univ. of Physics Dept. Staff	Outline of Atomic Physics	Wiley	1933
Planck, M. K.	The Universe in the Light of Modern Physics	Norton	1931
	Where Is Science Going?	Norton	1932
	Survey of Physics	Methuen	1925
Poincaré, H.	The Foundations of Science	Science Press	1929
	Science and Hypothesis	Scribner's	1906
Pupin, Michael (Ed.)	Science and Religion (symposium)	Scribner's	1931
Ramsey, F. P.	The Foundations of Mathematics	London	1931
Randall, J. H.	The Making of the Modern Mind	Houghton Miff.	1926
Reichenbach, H.	Atom and Cosmos	Macmillan	1933
Richtmyer, F. K.	Introduction to Modern Physics	McGraw-Hill	1934
Riehl, A.	Introduction to Theory of Science and Metaphysics	Kegan Paul London	1933
Ritchie, A. D.	Scientific Method	Harcourt Brace	1923
Rose, Wm. (Editor)	Outline of Modern Knowledge	V. Gollancz London	1931
Rougier, L.	Philosophy and the New Physics	P. Blakiston Philadelphia	1921
Royce, J.	Spirit of Modern Philosophy	Houghton	1892
Ruark, A. & H. C. Urey	Atoms, Molecules and Quanta	McGraw-Hill	1930

Russell, B. A.	A B C of Relativity	Harper	1925
	Analysis of Matter	Harcourt Brace	1927
	Analysis of Mind	Macmillan	1921
	Essay on the Foundations of Geometry	Cambridge U. P.	1897
	Our Knowledge of the External World	Open Court Chicago	1914
	Principles of Mathematics	Cambridge	1903
	Problems of Philosophy	Holt	1912
	Sceptical Essays	London	1928
	The Scientific Outlook	Norton	1931
Saidla, L. E. A. & W. E. Gibbs, eds.	Science and the Scientific Mind	McGraw-Hill	1930
Sampson, R. A.	Science and Reality	Benn, London	1928
Schroedinger, E.	Science and Human Temperament	Norton	1934
Sellars, R. W.	Philosophy of Physical Realism	Macmillan	1932
Sheen, F. J.	Philosophy of Science	Bruce	1934
Singer, C. J. (ed.)	Studies in the History and Method of Science 2 vols.	Oxford U. P.	1921
	Religion and Science Historically Considered	Benn, London	1928
Smith, D. E.	History of Mathematics 2 vol.	Ginn	1925
Smith, H. P.	History of Modern Culture	Holt	1930
Soddy, F.	Matter and Energy	Holt	1912
	Interpretation of the Atom	Putnam	1932
Sommerfeld, A.	Atomic Structure and Spectral Lines, 3rd ed. Revised.	Methuen, London	1923
Streeter, B. H.	Reality	Macmillan	1927
Sullivan, J. W. N.	Bases of Modern Science	Benn, London	1932
	Gallio, or The Tyranny of Science	Dutton	1927
Swann, W. F.	The Architecture of the Universe	Macmillan	1934
Tennant, F. R.	Philosophy of the Sciences	Cambridge	1932
Thomson, G. P.	The Atom	London	1930
	The Wave Mechanics of Free Electrons	McGraw-Hill	1930
Thomson, J. J.	Beyond the Electron	Cambridge	1928
Tolman, R. C.	Relativity, Thermodynamics & Cosmology	Oxford	1934
Westaway, F. W.	The Unending Quest	Blackie	1932
Whewell, W.	History of the Inductive Sciences	Appleton	1895

Whitehead, A. N.	An Inquiry Concerning the Principles of Natural Knowledge	Cambridge U. P.	1925
	Concept of Nature	Cambridge U. P.	1930
	Principles of Relativity with Applications to Physical Science	Macmillan	1922
	Process and Reality	Cambridge U. P.	1929
	Science and the Modern World	Cambridge U. P.	1932
	The Adventures of Ideas	Macmillan	1933
Whittaker, E. T.	A History of the Theories of Ether and Electricity	London	1910
Whyte, L. L.	Critique of Physics	Norton	1931
Wilson, H. A.	Mysteries of the Atom	Chapman & Hall	1934
Windle, B. C. A.	Catholic Church and its Reactions to Science	Macmillan	1927
Wolf, A.	Essentials of Scientific Method	London	1923
Woodruff, L. L. ed. (E. W. Brown and others)	The Development of the Sciences	Yale U. P.	1923
Wulf, Theodor	Modern Physics	Dutton	1929
Young, J. W. A.	Lectures on Fundamentals of Algebra and Geometry	Macmillan	1911
Zybura, J. S.	Present Day Thinkers and the New Scholasticism, 2nd ed. rev.	Herder	1927

NOTABLE ARTICLES IN PERIODICALS

Bulletin of the American Association of Jesuit Scientists

Articles by Frederick W. Sohon, S.J.

The Axioms of Mathematics	Vol. VIII, No. 3, pp. 36- 41
The Cardinal Number and Its Generalization	Vol. VII , No. 3, pp. 29- 38
Arithmetical Continuity	Vol. VII , No. 4, pp. 43- 51
The Geometry of Extended Reality	Vol. VIII, No. 2, pp. 25- 29
The Concept of Distance	Vol. IX , No. 4, pp.200-203

Clergy Review, Scholastic Philosophy and Modern Science. June 1933.

Modern Schoolman. Causality in New Physics. March, 1933 (McWilliams).

Review of Scientific Instruments with Physics News and Views

Under heading "Physics Forum" in all issues from end of 1932 to date will be found excellent articles on recent developments in Atomic Physics.

Scientific Monthly, The Uncertainty Principle in Modern Physics, by C. G. Darwin. May, 1932.

On the Nature and the Limitations of Cosmical Inquiries, by P. W. Bridgman. November, 1933.

School Science and Mathematics, Electrons, Photons and Waves, by P. M. Morse, M.I.T. February, 1934.

(N.B. A very fine popular reconciliation of wave and particle aspect of nature.)

Thought	Mar. 1927	Frumveller:	Looking At Things Scientifically.
	Dec. 1928	Frumveller:	Continuity as an Argument in Science.
	Dec. 1928	Gill, H. V.:	Physics and Metaphysics
	Mar. 1932	Ashton:	The Material Universe.
	Mar. 1934	Herzfeld, K.:	Cosmic Rays.

Both the *Catholic Encyclopedia* and the *Encyclopedia Brittannica* carry articles by authorities on many of the subjects referred to in this list; cf. e.g. Science Cosmogony

Scientific Induction Causality Relativity, etc.

A classified book-list with suggestions for further reading is given on pp. 317-319 for each chapter of Allen's *Electrons and Waves. The American Physics Teacher,* Vol. I, No. 3, September 1933, pp. 72-73; gives a bibliography on the history and philosophy of scientific doctrine, in an article by L. W. Taylor of Oberlin College on *A Modification of the Traditional Approach to College Physics.* John C. Slater and Nathaniel H. Frank of M.I.T. in their excellent *Introduction to Theoretical Physics* (McGraw-Hill, 1933; International Series in Physics) have a critical list of suggested references for more advanced work, pp. 561-563.

Loeb and Adams (*The Development of Physical Thought,* pp. 611-614) give a fine modern bibliography according to subject matter. Bernhard Bavink in *The Natural Sciences,* pp. 649-661, has a bibliography of foreign books as published in the original or in translation. Then on pp. 662-667 he gives a supplementary bibliography of original works in English.

A bibliography was printed, Typis at Sumptibus Fel. Rauch, Innsbruck, 1924, pp. 50, for the *Conventus Cosmologorum, S. J., Romae,* Oct. '24. Entitled *Conspectus Literaturae Cosmologicae exhibens opera recentiora philosophica et scientifica quaestionibus cosmologicis affinia,* it has the following sections:

Compendia Latina		p. 3
Literatura Anglica	(J. Bolland, Stonyhurst)	pp. 4- 7
Literatura Gallica	(J. de Tonquédec, Paris R. Devisé, Louvain)	pp. 8-16
Literatura Germanica	(A. Gatterer, Innsbruck C. Frank, Valkenburg)	pp. 17-44
Literature Hispania	(J.M. Dalmau and J. Puig, Sarriá. J. A. Laburu, Ona	pp. 45-48
Literatura Italica	(N. Longhitano, Acireale)	pp. 49-50

REV. JOSEPH P. GIANFRANCESCHI, S. J.

1875 - 1934

PRESIDENT OF THE PONTIFICAL ACADEMY OF SCIENCES

On Monday morning July 9, 1934, in peaceful and comforting surroundings, as only a special papal blessing can produce, Father Gianfranceschi rendered his soul to God. The distinguished Jesuit scientist, who was President of the Pontifical Academy of Sciences and Director of the Vatican City Radio Station, had the unique distinction of receiving the sacrament of Extreme Unction from the hands of His Holiness, Pope Pius XI.

Joseph Peter Gianfranceschi was born in Arcevia, Italy, on February 21, 1875. After finishing his classical and technical studies in the district schools, he enrolled in the school of engineering of the University of Rome. His exceptional ability for science and mathematics gave evidence of a bright future as a brilliant engineer for this clever young man. However, on November 12, 1896, the youthful Gianfranceschi interrupted his prominent career in the world, and he entered the Society of Jesus.

After two years of novitiate, he pronounced his vows on December 8, 1898. Even as a scholastic, his work in science was outstanding and his articles in engineering gave him recognition in scientific circles. He was ordained to the priesthood in 1909.

Now that he completed all his studies in the Society, he gave himself without reserve to his scientific work. He was the director of many problems of research and he contributed many articles to numerous scientific journals. He was an active member of many scientific societies and presented original papers at the various meetings. He was an outstanding figure at the Congress of Mathematics held in Rome, in 1908, at the Cambridge University Convention in 1912, and at the Toronto University Meeting in 1924. He was present at the centenary meeting of the illustrious Father Secchi, and at the centenary celebration of the University of London, in 1927.

The figure of Father Gianfranceschi was one of the most familiar and best known in Vatican scientific circles. When Pius XI wished to give new life to the Pontificia Accademia dei Nuovi Lincei, he found in Father Gianfranceschi, who was president of the academy, the man really adapted for the renovation. He revised the statutes of the academy and changed the title to: Pontificia Accademia delle Scienze—Nuovi Lincei; its new location was in the beautiful Casino of Pius IV, and a new financial foundation was donated.

As Director of the Vatican Radio Station, Father Gianfranceschi prepared that really glorious page in the history of radio transmission which

Vatican Radio Station

was written when Pius XI inaugurated the Vatican station. He was frequently in touch with the Holy Father. As President of the Pontifical Academy, he received the Pontiff each year at the inaugural assembly which Piux XI never missed. As Director of the Radio Station, Father Gianfranceschi was received by the Holy Father each Sunday evening, and he gave him all the news about the activity of the Vatican Radio Station. This audience with His Holiness was never omitted. Often Father Gian

franceschi received the Pope as his guest at the Radio Station, as for example at the installation of the Belinograph for transmission of photographs and also when Marconi went there for short wave experiments.

Then too, it was Father Gianfranceschi who prepared the radio transmissions which will always be remembered, such as when the Holy Pontiff broadcast the final message to the Eucharistic Congress at Dublin, and when he lighted the cross raised on Monte Senario on the opening day of the Holy Year.

He will always be remembered as the Chaplain of the two Arctic Expeditions sponsored by the Italian Government to the North Pole; one in the year 1918, and the other in 1928.

Even though he was ever busy with his scientific researches, he was always mindful of his priestly duties, and he kept in touch with his religious work by being appointed Pastor of the Church of St. Ignatius.

This is but a brief sketch of his glorious career and surely he will be numbered among the famous Jesuit scientists, because he helped greatly to uphold the great scientific tradition of the Society.

RICHARD B. SCHMITT, S.J.

Editor's Note. A list of the scientific publications of Father Gianfranceschi will be found in "L'Osservatore Romano", July 11, 1934, N. 158, page 2. The list is entirely too long for publication in the BULLETIN. From 1905 to 1932 Father Gianfranceschi published more than one hundred and thirty-eight articles.

REV. ADELBERT BLATTER, S. J.

1877 - 1934

SCIENTIST AND MISSIONARY

A few months ago, in Poona, India, a Jesuit priest, Father Adelbert Blatter, passed to his eternal reward at the age of fifty seven, after a life of intense activity on the Indian Missions. Because of his scientific achievements during a life devoted to educational work in the missions, a brief account of his varied activities should be of interest to readers of the BULLETIN.

Father Blatter was born in the year 1877 in the Canton of Appenzell in Switzerland, and received his early education in the land of his birth. As a boy he manifested the happy disposition which characterized him all during his life, and showed at an early age two traits that were fundamental in the making of the great botanist, a strong spirit of wanderlust and a real love of nature. He seems to have had many of the qualities that we like to associate with the typical American boy. More than once his school-boy pranks caused him to be shifted from one school to another. On one occasion he climbed to the top of the church steeple in the darkness of the night, and hung the Headmaster's shoes from the weathervane; on another occasion he fell from a considerable height and landed on a cow,—the young Swiss was not injured, but the cow's back was broken.

Everyone was surprised when this irrepressible youth entered the Jesuit novitiate in the year 1896; but beneath that happy disposition, bubbling over with the joy of living, was a deep piety, instilled into the boy by his mother, an ardent convert. The high point in his novice days was the four week pilgrimage, when he could be free and wander to his heart's desire. At the parish houses and religious communities where he sought lodging, all were astonished at the humor, the hearty laugh, and ravenous appetite of the young religious, who had already begun to develop the frame of a giant.

During his studies of the humanities and philosophy Mr. Blatter's many talents were very evident,—he had musical talent, he was well-versed in German literature, he picked up foreign languages with facility, and was the best writer in his class. Still botany remained his favorite subject, and when he was sent to Bombay for Regency, it was to teach botany and other natural sciences in St. Xavier College, a position which he filled with success for five years (1903-1908). During this time he made extensive botanical expeditions all over India from Kashmir to Ceylon, and by his publications won quite a reputation as a botanist. His

theological studies were made at the theologate of the French Jesuits in Hastings, England, (1909-1912) and while there he found time to visit the Botanical institutes in London, Paris, and Brussels, where his scientific publications gave him a welcome as an esteemed botanist. He was ordained to the priesthood in 1912, and after finishing theology, he was sent to Tertianship immediately, with a view to pursuing graduate work in botany in some European university. However, at the end of his Tertianship in 1914, the college in Bombay was in great need of professors, because the War had forced all the Germans out of Bombay, and Fr. Blatter being a neutral Swiss, he was sent back to Bombay toward the end of 1915.

As professor of botany during the four years (1916-1919), Fr. Blatter was at the height of his scientific production. During vacations he undertook extensive expeditions into the Hindus Valley near Kashmir, and across the border of Assam into the wilderness of China. Again scientific treatises appeared in great number, and with his own collections he established a first class botanical museum at St. Xavier College. More than once he was elected President of the Scientific Society of Bombay. In the year 1919 he was made Rector of St. Xavier College, and for five years there was little time at his disposal for scientific research. At the same time he was made a member of the Board of Administration of the University of Bombay, and in this capacity took a prominent part in the reform of the University, and supervised the curriculum of the different colleges and high schools.

In 1925 he was called to Rome to give expert advice on the mission situation. While there he saw an opportunity to devote himself again to scientific research, and at his own request he was sent back to India as a pastor of a small community. Here he found great consolation in his priestly work, yet he had enough time at his disposal to work over his scientific collections, and every day he sat at his writing desk till late in the night. Although he had been suffering from diabetes for some time he did not spare himself.

In 1930 he undertook another adventure, his last and the most difficult of all, into the mountainous regions of Waziristan, bordering on Afghanistan. A fall from his horse caused an injury which aggravated his sickness, and he returned from his trip, partially lamed, and a broken man. He kept at his work until several attacks of illness showed him the gravity of his condition, and the last months of his life were spent in a hospital at Poona.

Just an enumeration of Fr. Blatter's scientific publications would fill more than one page of this BULLETIN. His particular field of research covered the flora of India and Ceylon, Baluchistan, Persia, and Arabia, – in this field he was a recognized authority. He was the first to make a scientific investigation of the flora in the distant provinces of northwest India and the Indo-Afghanistan borderlands. His greatest work, "die Palmen Britisch-Indiens und Ceylons", appeared in 1926.

Fr. Blatter was eminent as a scholar, but it was the noble manliness of his character that drew hearts to him, for in his giant body beat a heart that was tender and the soul of goodness. His happy disposition and his cheerful laugh, when relating the pranks of his boyhood and his strange experiences, worked contagiously even on the soberest Englishman. Three Governors of Bombay and many high officials throughout India were his personal friends. On his expeditions he cared for the servants like a mother, and in his parish house he lived a life of poverty, in order to save as much as possible for the poor people with whom he sympathized deeply. He loved children and he was loved by all children at first sight, —to the youngsters this good man with a big beard had the appearance of the corpulent Father Christmas, the good St. Nicholas. His students found him an inspiration in their studies, but he also considered it his sacred trust to develop manly characters. The high esteem of all classes, Parsis, Hindus, and Mohammedans, for the Christlike scholar found eloquent expression in a meeting called on last July to honor and perpetuate his memory.

As an Apostle among unbelievers, he furnished them an example of a Catholic religious, in whom leadership and richness of intellectual endowments were combined with noble manhood in a living unity.

(Editor's Note:—This is a translation of an article that appeared in the October 1934 issue of *"Die Katholischen Missionen Illustrierte Monatsschrift"*.)

ALBERT F. MCGUINN, S.J.

BIOLOGY

THE GENETICS AND CYTOLOGY OF OENOTHERA

(Abstract)

Rev. Charles A. Berger, S.J.

Hugo deVries formulated his Mutation Theory of Evolution largely on the results of his extended experiments with Oenothera. As Genetics and Cytology developed, our understanding of the peculiar behavior of this genus became clarified. Many of the so called 'mutants' were found to be polyploids, tetraploid and triploid as well as several heteroploid forms being found. A number of diploid mutant forms remained however which could not be explained by mere change in the number of chromosomes. Renners' genetical analysis of these forms led him to form the theory that these apparently true breeding diploid forms were in reality hybrids or 'Complex Heterozygotes' as he termed them. The name signifies that they are heterozygous not in respect to one of a few genes but in respect to the two entire gene complexes that compose them. To each of these 'gene complexes' Renner gave a name. He further analyzed a number of these diploid mutants into their component complexes. The apparent true breeding behavior of these species can be explained by the theory of Balanced Lethal Genes (*developed by Muller for Drosophila*); on this theory the two pure forms segregating out in each generation are killed off and the heterozygous form appears to breed true. This explanation conforms with the observed large percentage of aborted pollen and inviable seed in Oenothera.

Cleland's cytological investigation of the genus revealed the meiotic ring-formation of chromosomes which gave an explanation of peculiar linkage of the haploid complexes.

The origin of the ring-formation of chromosomes can be explained by applying the theory of 'Segmental Interchange' evolved by Belling to explain the chromosome behavior in *Datura*. Segmental interchange differs from ordinary Crossing-over in that it takes place between non-homologous chromosomes, and from ordinary Translocation in that it is a reciprocal interchange; it may be defined as follows: reciprocal translocation of sections of non-homologous chromosomes.

BOSTON COLLEGE BIOLOGY DEPARTMENT

Rev. Francis J. Dore, S.J.

Biology is an Elective Course at Boston College, but if chosen, it is necessarily coordinated with Chemistry. This conjunction means that the student is engaged in laboratory work four afternoons weekly. With such a handicap against many forms of social activities, or of opportunities for gainful employment, it is surprising how many students choose this subject. In the Senior Year, there are at present thirty-nine taking Biology in the A.B. or Ph.D. Courses; and ten in the B.S. Course are majoring in this science. In the Junior Biology class, there are forty eight of the A.B. or Ph.B., and twelve of the B.S. groups; and there are eighteen B.S. Sophomores.

One of the M.S. students is studying the effect of electricity on nutrition in the case of Japanese Waltzing Mice; a Ph.D. man is working with the various forms of the Fungi which cause the prevailing skin lesion, called ''Athletes' Foot''. The cultures being used for this problem won much favorable notice at the recent meeting in Boston of the Association of American Surgeons. An article describing the research work of a recent Ph.D. of this department is appearing in the October issue of the Journal of the American Genètics Association, and is entitled ''Inheritance of the Crescent and Twin-spot Marking in the Viviparous Teleost, Xiphophorus Helleri''.

Thirty-eight men who obtained their Biological credits here entered medical schools this past September; sixteen went to Tufts, fifteen to Boston University, three to Harvard, one to Yale, and three to Georgetown. At the present time, Boston College is represented by over one hundred students in various medical schools, including, in addition to those mentioned, St. Louis, McGill, Albany, Long Island, Columbia, and Edinburgh.

It is interesting to contrast this number of embryonic doctors who made their pre-medical studies here, with the small number of practising physicians who are Boston College Alumni, earlier than fifteen years ago. The claim is sometimes made by those who do not approve of Catholic College training, that there are no prominent members of the medical profession who are graduates of this college. The charge is false, and is refuted by such names as those of Dr. Dunne of the Class of '77, who held a high rating as a physician in his practice in this country as well as in Europe; Dr. Barnes of the Class of '84, who was well known as a psychologist in addition to his medical reputation; Dr. McCarthy of the same year, who was the leading opthalmologist of Malden; Dr. Keany of the Class of '87, who was Head of the Dermatological Department of the Boston City Hospital,—not to mention more recent living graduates. But if the claim to fame of such men is not universally recognized, the critic would do well to scan the list of Boston students who are now engaged in medical study, and to heed the advice which Mark Twain is

said to have given to some people who were complaining of the Boston weather. Recently two Boston College men were admitted on their graduation from medical school to the Alpha Omega Alpha Society, which admits to its ranks only those who are among the first fifteen of their class all through their course, and they were the only two of that year who were graduates of the same college. It may be truthfully stated that any excellence found in this department is due to the splendid foundation laid by my predecessor, as well as to the efficient labors of my capable associates.

CHEMISTRY

ORGANIC CHEMICALS FOR MICRO-ORGANIC ANALYSIS

Rev. Richard B. Schmitt, S.J.

Micro analytical methods are being employed in research, industrial and educational laboratories. It is evident from current chemical literature that micro methods are finding favor in many types of chemical analysis. and most progressive laboratories are being equipt with apparatus for this type of analytical work.

At the present time, organic analysis is more complete and better organized than the inorganic methods. In order to teach organic analysis, it is necessary to procure pure organic compounds in order to verify the correctness and accuracy of these methods.

The following organic compounds have been used for the past three years and found to be satisfactory for a systematic course in micro-organic analysis.

Carbon—Hydrogen

Name	Formula	± 0.3 %C	± 0.3 %H
Azobenzene	$C_{12}H_{10}N_2$	79.08	5.54
Alcohol, Ethyl (abs.)	C_2H_6O	52.12	13.13
Alcohol, Ethyl, 1% H_20		51.60	13.90
Benzoic Acid	$C_7H_6O_2$	68.83	4.95
3-5 Dinitro Benzoic Acid	$C_7H_4O_6N_2$	39.62	1.91
Malic Acid	$C_4H_6O_5$	35.81	4.51
Phloroglucinol	$C_6H_6O_3$	57.12	4.80
Resorcinol	$C_6H_6O_2$	65.43	5.49
Succinic Acid	$C_4H_6O_4$	40.66	5.12
Tyrosine	$C_9H_{11}O_3N$	59.64	6.12

Molecular Weight

Name	Formula	± 10 points Molecular Weight
Azobenzene	$C_{12}H_{10}N_2$	182.10
Sulfonal	$C_7H_{16}O_2S_2$	228.00
Phenolphthalien	$C_{20}H_{14}O_4$	318.11

Metals in Organic Compounds

		± 0.15%
Sodium Chloride	Na Cl	39.34% Na
Sodium Benzoate	$NaC_6 H_5 COO (H_2O)$	15.97% Na
Sodium Salicylate	$Na C_7 H_5 O_3$	14.37% Na
Potassium Bitartrate	$K H C_4 H_4 O_6$	20.79% K
Calcium Lactate	$Ca C_3 H_5 O_3$	17.46% Ca

Sulphur

		± 0.2%
4 Nitro-chloro-benzene 2 sulfonic acid	$C_6 H_4 Cl N O_5 S$	15.86%
Sulfonal	$C_7 H_{16} O_2 S_2$	28.09%

Chlorine

		± 0.3%
o-Chloro-benzoic Acid	$C_7 H_5 O_2 Cl$	22.66%
p-Chloro-thymol	$C_{10} H_{13} O Cl$	19.22%
4 Nitro-chloro-benzene 2-sulfonic acid	$C_6 H_4 Cl N O_5 S$	14.93%

Carboxyl Group

			± 0.25%
Benzoic Acid	$C_7 H_6 O_2$	N.E. 122.05	36.88% COOH
Malic Acid	$C_4 H_6 O_5$	" 67.03	67.15% "
Octyl Adipic Acid	$C_{14} H_{26} O_4$	" 129.10	34.86% "
Salicylic Acid	$C_7 H_6 O_3$	" 138.05	32.60% "
Succinic Acid	$C_4 H_6 O_4$	" 59.02	76.25% "

Nitrogen: Dumas Method

		± 0.1%
Blank Test: Galactose	$C_6 H_{12} O_6$	0.0% N
Azobenzene	$C_{12} H_{10} N_2$	15.38% "
3,5 Dinitro-benzoic Acid	$C_7 H_4 O_6 N_2$	13.21% "
p Nitro-bromo benzene	$C_6 H_4 N O_2 Br$	6.93% "
o Toluamide	$C_8 H_9 O N$	10.37% "
Tyrosine	$C_9 H_{11} O_3 N$	7.73% "

Nitrogen: Kjeldahl Method

		± 0.1%
Blank Test: Galactose	$C_6 H_{12} O_6$	0.0% N
Myristic Amide	$C_{14} H_{29} O N$	6.17% "
Uric Acid	$C_5 H_4 O_3 N_4$	33.34% "
Amino-acetone Hydrogen Chloride	$C_3 H_8 N O Cl$	15.75% "
Urea	$C H_4 O N_2$	46.65% "

Methoxyl Group

Vanillin	$(OH) (CH_3O) C_6 H_3 (CH:O)$	20.40% CH_3O

AGREEMENT OF RESULTS IN THE STANDARDIZATIONS OF VOLUMETRIC ANALYSIS

Bernard A. Fiekers, S.J.

Very aften, the question arises "How closely should duplicate determinations agree in analytic chemistry?" What follows, answers the question for one type of standardization procedure and sets down the principle that may be extended to not a few others.

Due to the confusion existing between oxidation and metathetical normalities, and the consequent fact that concentration terms are to be encouraged rather than the normality term in the standardization of a solution, we will express the concentration of a standard solution in the terms of weight per cubic centimeter of solution as it is very convenient for the following calculations.

In reading any volumetric instrument, there is always a definite error that may be made even though the work is performed with reasonable care. For the 50 cc. burette, this value is generally accepted as .05 cc.

Let us call this quantity "dV", where the "d" part indicates a finite variation "delta". From an analysis of the factors involved, the approximation follows:

$dV \times \overline{W/cc.}$ = variation in the weight of solute for any volume of standard solution, "V".

where: $\overline{W/cc.}$ = (concentration factor) weight of solute per cc. of solution, when we take the average findings of duplicate determinations.

No matter what the volume of standard solution used, "dV" will always have a constant influence in altering the weight per cubic centimeter.

There also follows the approximation:

$dW/cc. \times \overline{V}$ = variation in weight for any volume of standard solution, "V". (Extension factor.)

That these approximations are nearly equal is patent if we consider that each expression represents the variation in the TOTAL weight contained in the WHOLE volume, provided

V nearly equals $\overline{V} + dV$ and

W/cc nearly equals $\overline{W/cc} + dW/cc.$

Equating them therefore, sets up the proportion:

$$\frac{dW/cc}{\overline{W/cc}} = \frac{dV}{\overline{V}}$$

This proportion is interpreted then as follows: The error in reading the volume bears that relation to the total volume used as the resulting error in weight per cc. bears to the total weight per cc. In other words, the error in the concentration of a solution expressed in grams of solute per cc. is proportional to the error in reading the volumetric instrument;

it is also proportional to the weight per cc. of solution as well as to the volume of solution used.

The formula clearly informs us then of a more advantageous technique in the use of volumetric instruments. Of the four quantities indicated, only two can be conveniently regulated by the analyst. These are the volume of the titrating solution that is to be employed, and the concentration of the solution (weight per cc.)

Looking at the formula in the following form:

$$d\overline{W}\ cc = \overline{W}/cc \text{ times } \frac{dV}{\overline{V}}$$

we can see that the greater the concentration of the solution, the greater the error; the greater the volume of the solution, the less the error.

There is a further advantage to be derived from the use of the first proportion, and it is the object of this paper. If in any standardization we got determinations that almost check, we can decide at once on their acceptance or rejection. Knowing dW, the difference between the checks, $\overline{W}$ the average weight of solute per cc. as calculated from the checks, $\overline{V}$ the average volume for the solutions used, we can calculate dV the corresponding variation in volume. If its value approximates the variation allowable in the reading of a volumetric instrument, we can accept the concentration values found as reasonable checks.

There is one condition that governs the use of the formula. The volumes of the standardized solutions should be approximately equal. This condition is usually fulfilled in ordinary volumetric practice. In the use of pipettes, the identity of the values for V is assured.

* * *

Ref. Wilkinson, Calculations in Quantitative Analysis. Ch. XIII.

MATHEMATICS

THE CHANGED ASPECT OF MATHEMATICS

Rev. Frederick W. Sohon, S.J.

Mathematics, like a caterpillar, crept on its belly for many centuries, and while it always provided abundant intellectual exercise for certain gifted individuals, its severe discipline and limited outlook made it a sort of intellectual asceticism that attracted only a few. I do not mean here to cast aspersion on this stage of mathematical development. I might with justice say that its discipline was not anywhere near severe enough—if I were not keenly aware that the early development of every science must necessarily be crude, and that the immense labor of logic demanded by the modern concept of mathematical rigor would have imposed such a heavy burden that any progress in the art and science of mathematics would have been necessarily very slow indeed, if not almost impossible. It is much easier to go back afterwards and correct mistakes in logic. But mathematicians, like the caterpillar, has developed wings, and the last century has seen a marvelous change in the science that would make it almost unrecognizable to its former devotees.

You will, perhaps, think that I am going to speak of the development of complex number systems, of the extension to space of more than three dimensions, of vectors, of quaternions, of tensors and of matrices,—but these are only the external concomitants of the change that has taken place deep within the spirit itself. Their introduction seems obvious if the mind has been prepared and has learned to look upon the older mathematical forms as mere particular applications of vastly more general principles. The introduction of these extensions was difficult and seemed revolutionary only because the more general principles underlying them were only vaguely felt at first without being clearly perceived or really understood. Without offering any disrespect to these interesting and fascinating mathematical developments, I should like to call your attention to something that I consider to have been vastly more significant. I refer to the notion of a *group* and to the multitude of new concepts that the unfolding of this notion has brought to our attention.

The honor of having established the Theory of Groups is generally conceded to a boy of 18 years of age, who was to be killed in a duel before he was 21 years of age. More than one remarkable mathematical discovery must be credited in the course of history to young men still in their teens, and the turbulent Evariste Galois who ended his riotous

life two years more than a century ago, has won for himself not merely the amazement, but the respect and admiration of the mathematicians of all time. But we must pass on to the notion of a group.

To understand the nature of a group, we must understand a transformation. You are familiar with the transformation of co-ordinates in analytical geometry. There are other kinds of transformations. We may interchange two letters in an algebraic expression. That is another kind of transformation. A transformation can usually be worked backwards, or undone. If I take the word MATE and change it to MEAT, the transformation consists of a cyclic interchange of the last three letters. The word MEAT can be transfermed back into the word MATE by a cyclic interchange in the opposite direction. The second transformation is called the inverse or reciprocal of the first transformation. Another example of a transformation would be the motion of a piece on a chess board. We may talk about different kinds of transformations. We may apply the same transformation repeatedly, or different transformations successively. For example if the transformation that changes MATE into MEAT be repeated, we get MTEA which does not spell anything, although that makes no difference. We think of the change of MATE into MTEA as the square of the transformation of MATE into MEAT. Another transformation would be to interchange the first and last letters. In this way I make EATM out of MATE and TEAM out of MEAT. The change of MATE into TEAM is the resultant of two different transformations, and it is spoken of as their product. It will be understood that these are merely examples of transformations, their inverse, power and products taken from the substitution of one letter for another, and that other examples might equally well be given from the chess board as well as from a variety of other applications.

With a certain amount of experimentation we soon realize that transformations obey perfectly definite laws just as numbers do. For example, we might show that the reciprocal of a product of transformations is the same as the product of the reciprocals of its factor transformations taken in reverse order. With further study the laws and properties are systematized, and if we use symbols to denote transformations we have on our hands a system that looks like algebra but is not algebra, because none of the symbols stand for numbers. Of course there are differences between this new algebra and the old metrical algebra. For example, if the change from MATE into MEAT is denoted by S, and the change from MATE into EATM is denoted by T, then the transformation from MATE into TEAM will be denoted by the product ST while the change from MATE into EMAT will be denoted by the product TS. Thus in the non-metrical algebra ST will not usually be equal to TS. It happens, however, that many principles really apply to both. So you see that the older metrical algebra and the new algebra of transformations are both particular applications of a more general algebra. The properties that are common to metrical algebra and the algebra of transformations will be the laws of the generalized algebra, while the properties in which they differ con-

stitute the specific difference to be assigned to the two original individual algebras.

How is this generalized algebra to be classified? Is it mathematics or merely a new branch of logic? The logicians proved neither to have been interested in it, nor to have been competent to develop it. The mathematicians needed the subject and so its development became the province of mathematicians. So we have the situation that all mathematics is not metrical, and that the new mathematics cannot be defined as a science that deals exclusively with quantity.

It may be here objected that even if the mathematician's symbols no longer stand for numbers, they originally arose out of numbers, and the results of the analysis are intended to be applied to numbers, and so this excursion out of the metrical field is not a serious disturbance to the formal object of mathematics. But the objection merely shows that the mathematician understands the scope of the new principles very much better than one who would propose such an objection. The new principles are so much more fundamental and so much wider in their application than the old mathematical principles that the mathematician cannot honestly regard them as ancillary to the petty principles of the older mathematics. They do not serve, they dominate. As they did not as yet constitute any science, their cultivation formed a legitimate field for conquest, and so de jure as well as de facto the province of mathematics has changed.

But we seem to have forgotten the notion of a group. A group is a set of transformations each having an inverse, and such that the product or resultant of any two transformations is also itself a member of the set. In working out the properties of a group, we usually discover certain properties that are unchanged or invariant under all the transformations of a group. The question of invariants naturally would excite a certain amount of attention. Then with the new generalized mathematics as a new background, it is not surprising to see the new methods begin to permeate problem after problem of the older mathematics. The theory of algebraic equations and the theory of differential equations become problems in the theory of substitutions groups and the theory of continuous groups, respectively. Not only new methods of attack but a new spirit seems to activate modern mathematics. We have but to pick up a modern treatise on geometry or on dynamics to see what a large part the concept of invariance and the theory of transformations now plays. In extending the realm of mathematics, it is not the conquest of a new field by the older mathematics. It is the old field that has been conquered by the new province. The aspect of mathematics has changed.

MAPPING IN THE COMPLEX PLANE

JAMES J. HENNESSEY, S.J.

In dealing with complex numbers and variables there frequently arises the relation such that the dependent complex variable w is a function of the independent complex variable z. The complex variables, w and z, just as the complex numbers, have the real variable as a special case. In algebraic symbols the complex variables may be written:

$$(1) \qquad z = x + i\,y$$

$$(2) \qquad w = f(z).$$

Since w is complex and a function of z, we have

$$(3) \qquad w = u + i\,v.$$

that is, u and v must be functions of x and y.

The question arises how can we represent this relationship geometrically. Since we have

$$w = u + i\,v$$
$$z = x + i\,y$$

we have four real variables, u, v, x, and y, to deal with. This suggests a figure in four dimensions. Quite conveniently the z points are represented in one plane called the Z plane and the w-points in another plane called

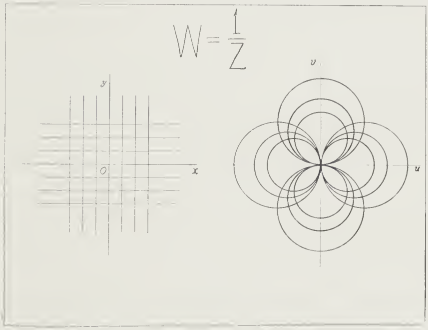

Figure 1

the W plane. As in considerations of functions of the real variable when x varies, its function also takes on various values; so with these complex variables there is a relationship between the two planes. As any curve is traced in the Z-plane by the point P, a corresponding curve will be traced, or, technically, mapped, in the W-plane by the point Q. Whether the W-plane will map upon the entire Z-plane or only upon a part of it depends upon the character of the functions.

Let us examine the equation $w = z^2$ (4). We have then $w = \mu + i v = (x + i y)^2 = x^2 - y^2 + 2 i x y$ (5) and equating the real and imaginary parts

(6) $u = x^2 - y^2$

(7) $v = 2 x y$

In polar coordinates these equations become

$$z = \rho (\cos \Theta + i \sin \Theta)$$

$$w = \rho' (\cos \Theta' + i \sin \Theta') = z^2 = \rho^2 (\cos 2 \Theta + i \sin 2 \Theta)$$

From the relation that exists between Θ and $\Theta' = 2 \Theta$ it is seen that half of the Z-plane maps into the whole of the W-plane and a half of the W-plane maps into a quadrant of the Z-plane; for example, the upper half of the W-plane maps into the first quadrant of the Z-plane.

Considering our equation $w = z^2$ let us investigate the mapping of some simple curves of the Z-plane upon the W-plane. Half of the Z-plane maps into the whole of the W-plane. (Figure 1). Consider the line $x = o$ of the Z-plane. $\mu = -y^2$ by (6)

$v = o$ by (7)

$\therefore w = -y^2$.

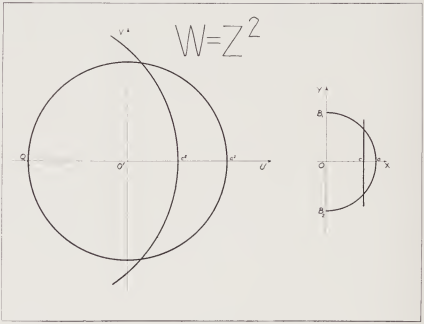

Figure 2

Thus for any value of y, either positive or negative, w has a negative real value and so the whole of the y-axis maps into the negative u-axis. The points, B_1 and B_2 map into the same point Q in the W-plane.

If in the Z-plane there is a semicircle of radius a then w describes a complete circle of radius a^2 about the orgin. Thus

$$x^2 + y^2 = a^2 \text{ (circle) or } x^2 = a^2 - y^2.$$

$$\mu = a^2 - 2 y^2 \quad \text{by (6)}$$

$$v^2 = 4 x^2 y^2 = 4 y^2 (a^2 - y^2) .$$

Squaring μ and adding v^2

$$\mu^2 + v^2 = a^4 = (a^2)^2$$

If z describes the line x = c, then w describes a parabola cutting the U-axis at c^2. $u = c^2 - y^2$ or $y^2 = c^2 - \mu$ by (6)

$$v = 2\,c\,y \qquad (7)$$

$$v^2 = (2\,cy)^2 = 4\,c^2\,(c^2 - \mu)\,.$$

In like fashion other curves in the Z-plane may be mapped upon the W-plane. The function $w = z^2$ determines an electrostatic field.

The function thus far considered, namely $w = z^2$ is a special case of the general function $w = z^n$. As in the case we examined, it will be readily seen that for this function (1 n)th of the circle in the Z-plane maps into the whole of the circle in the W-plane.

An interesting map (figure 2) of $w = z^n$ is had when $n = -1$; the function is then $w = \frac{1}{z}$. When x = c and y = c′ in the Z-plane the maps become mutually orthogonal systems of circles with centers on the u and v axes. The circles have a common point of tangency.

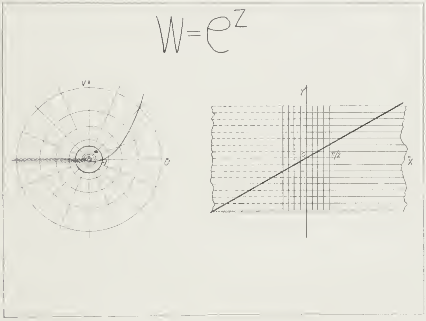

Figure 3

Figure 3 is the map of $w = e^z$. A line parallel to the x-axis maps into a half ray in the W-plane beginning from the origin. A line parallel to the Y axis maps into a circle. When x = c then

$$u = e^x \cos y \qquad\qquad v = e^x \sin y$$

$$u^2 + v^2 = c^{2x}\,(\cos^2 y + \sin^2 y) = e^{2x}$$

The line y = m x maps into a logarithmic spiral about the origin.

The logarithmic, trigonometric and hyperbolic complex functions have a particular significacce and importance in mathematical physics and more particularly in electricity, magnetism and hydrodynamics.

INTERPOLATION

Rev. Thomas D. Barry, S.J.

It will probably be conceded by all that interpolation is a nuisance. But, since it is obviously impossible to tabulate values of a function for all possible values of an independent variable, interpolation becomes a necessity in computing. The purpose of this paper is to give some of the more important interpolation formulae and their applications.

All tables are based on a functional relationship between two or more variables; thus, $F = f(x,y, \ldots)$. We shall consider chiefly the case where there is only one independent variable, and since, outside of tables of logarithms and trigonometric functions, the independent variable is most commonly the time, we shall consider the case where $F = f(T)$. If we tabulate values of F for equidistant values of T, we get a table of the following form:—

$T - 3\omega$	F_{-3}
$T - 2\omega$	F_{-2}
$T - \omega$	F_{-1}
T	F_0
$T + \omega$	F_1
$T + 2\omega$	F_2
$T + 3\omega$	F_3

In this table, the first column gives the various values of the independent variable, usually called the argument of the table, one of them being arbitrarily assigned the notation T, the rest being distinguished from it by the subtraction or addition of multiples of the common interval ω. The second column gives the values of the function corresponding to the individual values of the independent variable or argument. If now we difference the values of the function, subtracting each from the one following, and write these results in the next column, *between* the respective values of the function; and then do the same thing for that column, and so on, we arrive at the following scheme. (N.B. The notation varies with the different formulae and also in different books for the same formula. The notation here used was selected as being convenient for use with all the formulae to be considered.)

Arg.	*Funct.*	*1st diff.*	*2nd diff.*	*3rd diff.*	*4th diff.*	*5th diff.*
$T - 3\omega$	F_{-3}					
		a_{-2}				
$T - 2\omega$	F_{-2}		b_{-2}			
		a_{-1}		c_{-1}		
$T - \omega$	F_{-1}		b_{-1}		d_{-1}	
		a_0		c_0		e_0
T	F_0		b_0		d_0	
		a_1		c_1		e_1
$T + \omega$	F_1		b_1		d_1	
		a_2		c_2		
$T + 2\omega$	F_2		b_2			
		a_3				
$T + 3\omega$	F_3					

Starting with the third column, each column gives the difference between the values in the preceding column, the *upper* value always being subtracted from the *lower*. Great care must be taken with regard to the signs. The quantities in these columns are called respectively the 1st, 2nd, 3rd differences, etc. It should be noted that the even differences fall on the same lines as the functions, while the odd differences fall between the lines. In what follows, T is taken as the time in the argument next preceding the time t for which the function is required, and n as the ratio between t T and ω, the interval of the argument. Thus n is always less than unity. The values of the other coefficients, functions of n, are usually obtainable from tables.

$$F_n = F_0 + n\,a_1 + \frac{n(n-1)}{2!}\,b_1 + \frac{n(n-1)(n-2)}{3!}\,c_2 + \frac{n(n-1)(n-2)(n-3)}{4!}\,d_2 .$$

Newton's Formula:—

The notation used here for the differences is not the same as that usually found, but was changed to fit the common scheme. In any case, each difference used is found half a line below that in the preceding column. As an example of the use of this formula, let us find the right ascension of Antares (α Scorpii) at transit at Greenwich on April 4, 1934. The data are found in the American Ephemeris, 1934, p. 469.

Date	*F = a*	*1st diff.*	*2nd diff.*	*3rd diff.*	*4th diff.*
	$16^h 25^m$				
Mar. 12	$23.^s186$				
		+.325			
22	23.511		−.017		
		+.308		−.004	
Apr. 1	23.819		−.021		+.003
		+.287		−.001	
11	24.106		−.022		−.003
		+.265		−.004	
21	24.371		−.026		
		+.239			
May 1	24.610				

Here, T is April 1, the date preceding April 4, the interval being 3 days. The interval in the argument is 10 days, therefore $n = +.3$.

$$F_0 = 16^h\ 25^m\ 23^s.819$$

$n = +\,.3$	$a_1 = +\,.287$	Product	=	$+\,.086$
$\dfrac{n(n-1)}{2} = -\,.105$	$b_1 = -\,.022$	"	=	$+\,.002$
$\dfrac{n(n-1)(n-2)}{6} = +\,.060$	$c_2 = -\,.004$	"	=	$+\,.0$

$$a = 16\ \ 25\ \ 24.907$$

Stirling's Formula :-

$$F_n = F_o + n\frac{a_o + a_1}{2} + \frac{n^2}{2!} b_o + \frac{n^2(n^2-1)}{3!} \cdot \frac{c_o + c_1}{2} + \frac{n^2(n^2-1)(n^2-4)}{4!} d$$

The terms $\frac{a_o + a_1}{2}$ and $\frac{c_o + c_1}{2}$ may also be written $a_1 - \frac{1}{2} b_o$ and $c_1 - \frac{1}{2} d_o$.

This formulia makes use of the even differences in the same line as the initial function F_o, and the means of the odd differences just above and below that line. The application to the above example is as follows.

			F_o =	16 25 23.819
$n = +.3$	$a_1 - \frac{1}{2} b_o = +.297$	Product	=	+ .088
$n^2/2 = +.045$	$b_o = -.021$	"	=	− .001
$n^2(n^2-1)/6 = -.045$	$c_1 - \frac{1}{2} d_o = -.004$	"	=	0
			a =	16 25 24.906

Bessel's Formula :-

$$F_n = F_o + n\,a_1 + \frac{n(n-1)}{2!}\,\frac{b_o + b_1}{2} + \frac{n(n-1)(n-\frac{1}{2})}{3!} c_1 + \frac{(n+1)n(n-1)(n-2)}{4!}\,\frac{d_o + d_1}{2}$$

This formula makes use of the odd differences in the half line just below F_o and the means of the even differences in the lines containing F_o and F_1. Here again the means may be put into the forms: $b_1 - \frac{1}{2} c_1$, etc. Using the same example:—

			F_o =	16 25 23.819
$n = +.3$	$a_1 = +.287$	Product	=	+ .086
$\frac{n(n-1)}{2} = -.105$	$b_1 - \frac{1}{2} c_1 = -.021$	"	=	+ .002
$\frac{n(n-1)(n-\frac{1}{2})}{6} = +.007$	$c_1 = -.001$	"	=	0
			a =	16 25 24.907

When n approaches unity, that is, when the time for which the function is to be interpolated is closer to the second of two values of the argument, backward interpolation becomes more convenient, requiring the following changes in the above formulae. In all cases F_0 is the function corresponding to the value of the argument immediately *following* the required time. Then in Newton's formula, change the sign of n in the even terms on the right hand side, and take the differences in ascending order, that is, each one in the half line above the preceding difference. In Stirling's formula, merely change the sign of n, throughout. In Bessel's, change the sign of the even terms, take the odd differences in the half line above F_0 and the means of the even differences in the F_0 and F_{-1} lines.

Relative advantages of the three formulae. Newton's is probably the easiest to remember because of the simple manner in which the coefficients are formed, and because there is no question of combining differences. The formula becomes necessary near the beginning or end of a given series, since the higher differences cannot be found from the date at hand. Those of Bessel and Stirling are otherwise more commonly used because the formulae converge more rapidly. Bessel's is probably a trifle more accurate, especially when n is near one-half.

These formulae are apparently quite complicated, but, since tables are usually formed with the interval of the argument so selected as to give sensibly constant second or third differences, only a few terms are needed in practice. When the first differences are sensibly constant, as is the case in ordinary tables of logarithms and trigonometric functions, simple interpolation is sufficient: $F_n = F_0 + na_1$. Auxiliary tables of proportional parts are a common aid in expediting this interpolation. Where it is possible to have the function proceed in steps of one unit, critical tables should be used to avoid interpolation entirely. In these, the argument column gives the values of the independent variable at which the function changes by one unit.

Tables are sometimes constructed without the differences of the functions, but with the derivatives, or rates, corresponding to the functions. Thus, the American Ephemeris has contained tables giving the moon's position for every hour of Greenwich Civil Time, with the variation per minute at each hour. (The volume for 1935 gives the regular differences instead.) For interpolation of tables of this kind, the *rates* are differenced according to the above scheme, and the following formula may be used:—

$$F_n = F_0 + n\,\omega\left[F_0' + \frac{n}{2}\,\frac{a_0 + a_1}{2} + \frac{n^2}{6}\,b_0 + \frac{n}{12}\left(\frac{n^2}{2} - 1\right)\frac{c_0 + c_1}{2}\right].$$

Example: to find the declination of the moon on 1934 Aug. 12, $2^h\,23^m\,47^s.2$ $= 2^h\,23^m.787 = 2^h.396$ G. C. T. (Data from the Ephemeris, page 89.)

T	*δ (= F)*	*Var. per min (= F′)*	*1st diff.* a	*2nd diff* b
0^h	+ 6° 57′ 42″.3	− 13″.313		
			−.030	
1	44 22.6	13.343		+ .001
			−.029	
2	31 1.2	13.372		0
			−.029	
3	17 38.0	13.401		+ .001
			−.027	
4	+ 6 4 13.1	− 13.456		

Here the interval of the argument, ω, is 1 hour or 60 minutes.

$$n = +{}^{h}.396 \qquad n\,\omega = 23^{m}.787 \qquad F_o' = -13.372$$

$$n\,2 = +.198 \qquad \frac{a_o + a_1}{2} = -.029 \qquad \text{Product} = -.006$$

$$n^2\,6 = +.026 \qquad b_o = -0 \qquad \text{“} = 0$$

$$(\qquad) = -13.378$$

$$n\,\omega\,(\qquad) = -318''.22$$

$$= -5'\ 18''.2$$

$$F_o = +6 \quad 31 \quad 1.2$$

$$\delta = +6^\circ\ 25'\ 43''.0$$

If the differences of $F'(T)$ are fairly constant, as in the above example, the procedure may be considerably simplified by the following rule:—Find by simple interpolation the value of the tabular derivative which belongs midway between the required function and the nearest tabular function (F_o); multiply this quantity by the units contained in the entire interval (t-T), and apply the product to F_o. Thus, in the above example, we find the derivative at the required time to be —13.372 + .396 (—.029) = —13.384. Midway between that time and 2 hours, the variation per minute is —13″.378 per minute. This is multiplied by the number of minutes in the interval, 23.787, and the product added to the δ at 2 hours, giving the above result.

A final word about double interpolation, which is used to find a function of two variables. In this case, the independent variables form two arguments, one vertical and the other horizontal. Interpolation is made first with respect to one of the variables in the two rows or columns which include the other, then using these new quantities, with respect to the other variable. The following is taken from the moonset tables in the American Ephemeris for 1934, for the meridian or Greenwich (longitude = 0°).

Date	*Lat.*	$+35^\circ$	$+40^\circ$
Feb. 13		$17^{h}\ 14^{m}$	17 5
Feb. 14		18 27	18 22

Suppose we wish to find the local civil time of moonset on February 13 at a place whose longitude is 90°W (= + 6^{h}) and latitude is + 38°. We first find it for long. 0°, and latitude + 38°, by simple interpolation. The interval of the horizontal argument is 5°, so n = 3 5 = .6. Hence the moon will set at that latitude on the meridiam of Greenwich on Feb. 13 at $17^{h}\ 8^{m}$, and on February 14 at $18^{h}\ 24^{m}$. Now we want the time for a place 6 hours or .25 day west of Greenwich. Therefore with this value of n we interpolate between $17^{h}\ 9^{m}$ and $18^{h}\ 24^{m}$, and find the result to be $17^{h}\ 27^{m}$, or 5:27 P. M.

PHYSICS

KELVIN'S THERMODYNAMIC SCALE OF TEMPERATURE

DANIEL LINEHAN, S.J.

When the scientist rests from the work of discovering things new, or from the labours of applying more ancient findings to recent needs, he turns to the correlating of his multitude of facts neath the protection of as few and as stable laws as possible. Furthermore, the systems of measurement pertaining to the various branches of science must be reduced to such absolute and fundamental norms that they will cease to depend upon variables that will lessen their value and render calculations for a future date more difficult and less trustworthy.

In the measurement of temperature the ordinary method is the expansion of a liquid, solid or, more rarely, of a gas. In truth, a fair amount of accuracy and certitude can be obtained by this method, yet it cannot fully satisfy the scientist. He realizes that, as long as his measurements remain dependent upon the nature of the various substances employed, the goal mentioned above cannot be attained. As long as the magnitude of the linear or volume dimensions is a function of such variables, this scale of measurement is not absolute in the true sense of the term.

It was William Thompson, perhaps better known to some as Lord Kelvin, an Irishman and onetime professor of physics at Glascow, who made possible the use of absolute units in measuring temperature. This, by the way, was not his only contribution to the field of heat in physics, for further, his many discoveries and formulated laws show us that none but such an untiring research scientist as he could have come upon the system we shall briefly explain.

First of all we must recall our definition or explanation of Absolute zero, since Kelvin too, has employed this as the rock bottom of his scale.

In the standard gas thermometer, it is the increase of pressure which the molecules of the confined gas exert against the walls of a vessel of constant volume that determine the temperature measurement. It may be proven empirically that 1° change on the C. scale is such as will cause the pressure, which these molecules of a confined volume of H exert, to change 1/273.2 of its former pressure at O°C. By cooling the gas to -273.2°C. this pressure would be reduced to zero, or in other words, their motion will have ceased entirely. It is more logical to call such a point zero than that point where at water becomes ice.

Whether or not Lord Kelvin obtained his idea of temperature scales

from Carnot's explanation of the reversible heat engine does not matter. But, at least, it resembles that phenomena so closely that we may transmit an explanation of Kelvins graph here for lack of space. It is sufficient to say that, graphically the areas formed by the intersection of pairs of adiabatics and pairs of isothermals correspond to quantities of heat. In choosing such an explanation Lord Kelvin eliminated those difficulties arising from diversities of substances and obtained an independent foundation for his scale of thermal measurements.

If we take the "area" referred to above and represent it by 'A' and allow the temperature corresponding to any isothermal to equal Θ, then the area enclosed by Θ° and $(\Theta - 1)^\circ$ and the adjacent adiabatics will equal A n where 'n' is an arbitrary number of divisions, 100 being the usual number chosen to agree with the centigrace scale. Similarly, the difference between the quantity of heat Q' absorbed at Θ, and Q'' rejected at $\Theta - 1$ equals $Q' - Q'' = A\ 100$.

Continuing the evolution of this formula we may again eliminate much of the explanation since it resembles that of Carnot's engine so closely. Absolute zero, where the efficiency of Carnot's reversible engine is determined we have $\frac{Q' - Q''}{Q'} = \frac{\Theta' - \Theta''}{\Theta'}$ or $1 - \frac{Q''}{Q'} = 1 - \frac{\Theta''}{\Theta'}$ i.e., the ratio of any two temperatures is equal to the ration of the heat absorbed to the heat rejected by an ideal engine working between these temperatures. Furthermore, Q' and Q'' can be measured in terms of energy since the first law of thermodynamics demonstrates that heat is proportional to work. Thus, from mechanical consideration only, we may obtain the ratio of any two temperatures and it will be independent of the particular substance employed in converting the work into heat. This energy, in fine, is the norm with which Lord Kelvin compares the temperatures he is attempting to determine. His scale is therefore absolute in the true sense of the word, and likewise independent. Moreover, this scale being arbitrary, may be adjusted to as great or as small an amount as the scientist desires, although the two points ordinarily chosen are those of boiling water and melting ice.

Time will not allow here either the proof or explanation of the various phenomena connected with the application of this scale, e.g., showing how temperatures measured by this method agree with those measured with the aid of a 'perfect' gas thermometer. This is of course a theoretical determination since experiment has shown that a perfect gas does not exist. But even temperatures measured on the constant pressure thermometer, employing hydrogen, will coincide to a close approximation with those measured on Lord Kelvin's scale.

If the reader cares to peruse the various texts on heat he will find there suitable examples demonstrating the above phenomena.

"CORRESPONDENCE"

"PREREQUISITES FOR A COLLEGE DEGREE"

Every year after the first three or four Physics examinations, and their sad results, I have been asked this question by many of the Juniors in A.B. course. "WHY DO WE NOT START THE LECTURE METHOD IN PHILOSOPHY AND THE SCIENCES IN OUR FRESHMAN YEAR? For the last five years the reason in back of that question was that the first two years in the Arts course was so like the High School course that the students lost interest. The cause of the question is the fact that in the examinations in both Chemistry and Physics we find blank spaces where the answers to problems should be. Also they do not know how to study any part of the matter that is not given in the lectures. At first there is an angry protest about the cold lecture method with the objective rating for intrinsic worth. The sudden change from the warm paternal method in the small class where the extrinsic conditions may regulate marks to the cold lecture system with objective marks causes this hatred for the sciences. Naturally the student wants to know why this method was not started in Freshman.

My answer has been that our system has worked in the past. After four years of High School training, the Freshman is ready to study Poetry in Latin, Greek, and English, and Rhetoric in the same three languages in Sophomore. But the student no longer takes this answer. As one said last week, "Why not face the facts? You have no control over the Public High Schools and over sixty percent of us are not prepared for these courses. We are just as well prepared to start Philosophy and the natural sciences in Freshman as well as in Junior year".

How can we answer these students? To be honest I have found the Freshman B.S. student far better prepared for his course in Physics than the Junior Arts student. The reason is that the Freshman will study. This is not a criticism of any of the teachers, but rather a sympathetic appreciation of their difficulties. It is no criticism of anyone who has authority to make the changes in the schedule of studies. It is merely stating the difficulties that we have in the Arts course. The solution so far has been to drop any courses that are difficult outside the classics. On account of the lack of preparation in High School, our classics teachers have to toil night and day to feed some predigested food to their students and then by constant repetitions hope to have some return for all their work. Each year more time is required to make up these deficiencies in the classical education given by the Public High Schools. And each year more of the

sciences are thrown overboard because they are difficult. Before we drop any more branches would it not be well to consider our reason for existence in the educational world and study the means to obtain our purpose in education.

What is our purpose? Nobody will deny that the reason for the many sacrifices of both the parents and our own teachers is that boys may have training in their Catholic religion, in the true philosophy and that they may study the classics and the sciences in the warm atmosphere of Christ's true religion. Otherwise the students could go to the State Colleges and join some Newman Club. Our major branches are then both the lectures in religion and the lectures in Philosophy. We have the first for four years. Why not Philosophy for four years? The required time for both the classics and the sciences could be spread out for four years. In this way the student would have a lecture method in the Arts course before he is convinced that the college is the same as High School.

In this way there would be no reason for dropping Mathematics or General Chemistry or Physics or any of the sciences. On account of the small number of hours the science teacher has to advance in the matter for one full hour. A lecture then means that the teacher gives new matter for one hour. We have to have "Quizzes" in small sections. Of course there is very serious difficulty. In large lecture classes some of the class would be free during this "quizz" time. It means that some "Quizz" classes would be late in the afternoon. The only reason against it is that "the students would tear down the building" if they were free for an hour. Are we running a grammar school? The great confession that our students would not study in the library is another proof that the silver spoon method of feeding predigested matter to the students, and the constant repetition method, gives no matter to the student for study. The Junior Arts students have confessed that they do not know how to study. They will write themes or memorize translations, but are at a complete loss when told to study in Philosophy or the sciences. When the Philosophy lectures and Religion lectures are one hour of advance matter, there will be plenty of time needed for study. When the examinations are tests in original problems and require extensive reading there will be plenty need of study. Of course if these courses are merely memory lessons like the catechism then there is not any need for a change. It is true that the teachers of Religion and Philosophy will be as unpopular as the science teachers if they demand study and reading and the solution of problems. If the students are rated objectively by their ability to master the matter and not from memory work from the constant class repetitions, then religion and philosophy will also be thrown out of the Arts course because they too are difficult.

Will someone then kindly give me the answer to this question: "Why not start the lecture method in Philosophy and Religion in the Fresh year and carry it through for four years?" According to the students and our graduates the silver spoon method of constant repetition has failed not only to make them students of the classics but also to do any real work in

Religion and Philosophy. The proof of this failure as given by the students is their helplessness in the Junior Arts course to study or read their religion or philosophy books. If there is no theme to write, or translation to memorize they feel free to sit back and enjoy life. Another proof is their disgust with the teacher who seeks to be very popular and only feeds some predigested matter that needs no study and then by spending the hours in constant repetition removes any incentive for reading around the matter or studying the matter. Why is it wrong to spread out the classics course for four years as we have spread the B.S. course for four years? Why is it wrong to treat our students as college men and give them free periods to study when quizzes are being held? Why is it wrong to ask the A.B. students to study the matter given in lectures and rate them objectively by their intrinsic worth? Why not face the facts, as the students tell us? Is our purpose to educate our students in their religion and true philosophy as well as to make them fine students in the classics and the sciences? Or is it, as the boys complain, merely to make up for the deficiencies in some of the High Schools over which we have no control, and to do this throw aside all the training of the sciences and the Queen of the sciences, merely because they are difficult? I would be grateful for any help in the solution of these questions now offered by our students and graduates.

"Professor of Physics."

PHYSICS IN THE ARTS COURSE

A proposal of the late Father Strohaver, formerly dean at Georgetown, to transfer Physics from the column of requisite courses to that of electives toward the A.B. degree occasioned Fr. Kolkmeyer's admirable appraisal of Physics in the last Bulletin.

Without discounting the least from Fr. Kolkmeyer's able remarks, the present writer leans to the opinion that Fr. Strohaver's proposal was not lacking in wisdom. From the student's point of view, an enforced course of physics is an imposition, especially on the Junior who may have elected some other subject as his major interest. With the required courses in Philosophy and Evidences occupying two-thirds of his time, he has little enough time and energy left to concentrate on his major.

From the viewpoint of the educator and the educational institution, it appears valueless to force a twenty or twenty one year old student to take such an expensive course as Physics when the student himself is not interested or so inclined. With the exception of Georgetown, very few colleges and universities, Jesuit or secu'ar, insist upon Physics for the A.B. degree. Most colleges or universities have not the laboratory space and the expensive equipment that would be necessary for enforcing Physics upon their Arts students. Laboratories and equipment are over-crowded with science students majoring in Physics, and it is excellent practice to place laboratory facilities at the disposal of interested students only, rather than further to over-crowded laboratories and over-whelm teachers with students who wish they had never seen the inside of a laboratory.

The present writer would prefer the introduction of Latin as a requisite for the B. S. degree rather than the enforcement of Physics as a requisite for the B. A. degree. Latin has always held pre-eminent place in the Ratio Studiorum, and it is quite indispensible toward the understanding of numberless scientific and philosophical terms.

REV. JOHN P. DELANEY, S.J.

RECENT BOOKS

The books mentioned in this column are recommended by our Science Professors as suitable for the Science Libraries.

BIOLOGY

The Lichen Flora of the United States, by Bruce Fink. University of Michigan Press.

Life Forms of Plants and Statistical Geography, by C. Raukiaer. Oxford University Press.

The Gramineae, by Agnes Arber. Cambridge University Press.

Plant Biochemistry, by W. E. Tottingham. Burgess Publishing Co.

Recent Advances in Allergy, by George W. Bray. Blakiston's Son & Co., Philadelphia, Pa.

The Algae and Their Life Relations. University of Minnesota.

Economic Plants, by E. E. Stanford. Appleton, Century Book Co., New York, N. Y.

CHEMISTRY

Handbook of Chemistry, Edited by Norbert A. Lange, Ph.D. Handbook Publishers, Inc., Sandusky, Ohio. 1934.

The Kinetics of Reactions in Solution, by E. A. Moelwyn-Hughes. Oxford Press, 1933.

Physico Chemical Methods, by J. Reilly & W. N. Rae. Second Edition, revised. D. VanNostrand Co., New York.

Elementary Quantitative Analysis. Theory and Practice. By Hobart H. Willard & N. Howell Furman. D. VanNostrand Co., New York, 1933.

Chemie der organischen Farbstoffe, Vol. I. By Dr. Fritz Mayer. Third Revised Edition. Julius Springer. Berlin, Germany. 1934.

A Study of Crystal Structure and Its Applications, by Wheeler P. Davey. McGraw Hill Book Co., New York. 1934.

A Manual of Biochemistry, by J. F. McClendon. John Wiley & Sons, Inc., New York. 1934.

Bilder zur qualitativen Mikroanalyse anorganischen Stoffe, von W. Geilman. Leopold Voss, 18 Salomonstrasse, Leipzig C 1, Germany. 1934.

MATHEMATICS

Vorlesungen ueber Differential—und Integralrechnung........R. Courant
Band I: Funktionen einer Veraenderlichen (2nd ed.) 1930 (R.M. 18.00
Band II. Funktionen mehrerer Veraenderlicher (2nd ed.) 1931
Vienna: Julius Springer. (R.M. 19.00

Vorlesungen ueber Algebra ....Bauer-Bieberbach
Leipzig: B. G. Teubner, 1933. (R.M. 14.00

Partial differential equations of mathematical physics......A. G. Webster
Leipzig: B. G. Teubner, 1933 (2nd ed.) (R.M. 18.00

Encyklopaedie der mathematischen Wissenschaften
III. Bd. Geometrie. II. Teil. II. Haelfte.

Heft 12: Algebraische Transformationen und Korrespondenzen.
L. Berzolari (R.M. 14.00

Heft 13: Titel und Inhaltsverzeichnis zu Bd. III, II. Teil, II. Haelfte
und Register zu Bd. III, II. Teil. (R.M. 3.00
Leipzig: B. G. Teubner, 1933.

Interpolation und genaeherte Quadratur ....G. Kowalewski
Leipzig: B. G. Teubner, 1932. (R.M. 9.60

Continuous Groups of Transformations ....L. P. Eisenhart
Princeton University Press, 1933.

Reihenentwicklungen in der mathematischen Physik..............J. Lense
Leipzig: Walter de Gruyter, 1933. (R.M. 9.50

Integralgleichungen ....G. Kowalewski
Leipzig: Walter de Gruyter, 1930.

The Calculus of Finite Differences ....L. M. Milne-Thomson
New York: The Macmillan Co., 1933.

Vorlesungen ueber Variationsrechnung ....Oskar Bolza
Leipzig: Koehlers Antiquarium, 1933. (Reprint of 1909 ed.)
(R.M. 20.00

The Theory of Matrices ....C. C. MacDuffee
Vienna: Julius Springer, 1933.

Einleitung in die hoehere Geometrie ....L. Bieberbach
Leipzig: B. G. Teubner, 1933. (R.M. 6.40

PHYSICS

Where is Science Going? ....Max Planck
New York: W. W. Norton & Co., 1932. ($2.75)

The General Properties of Matter ....Newman and Searle
New York: The Macmillan Co., 1933 (2nd ed.) ($4.00)

Principles of Mathematical Physics ....W. V. Houston
New York: McGraw-Hill Book Co., Inc., 1934. ($3.50)

A Study of Crystal Structure and its Applications..........W. P. Davey
New York: McGraw Hill Book Co., Inc., 1934. ($7.50)

Report on Band Spectra of Diatomic Molecules...............W. Jevons
London: The Physical Society, 1932. (21s.)

The Classical Theory of Electricity and Magnetism..Abraham and Becker
Toronto: Blackie & Son, 1932. ($5.00)

Infra Red Photography ....S. O. Rawling
Toronto: Blackie & Son, 1932. ($1.25)

The Structure of Molecules ....P. Debye
Toronto: Blackie & Son, 1932. ($5.00)

Lecture and Laboratory Suggestions

A Method of Producing Uniform Magnetic Fields..............I. I. Rabi
(The Review of Scientific Instruments, Feb. 1934.)

Explosion Hazard in Coating Mirrors.......................J. C. Rice
(Journal of Chemical Education, Apr. 1934.)

Rebuilding Old Storage Batteries ....R. Bavkuloo
(Popular Mechanics, March, 1934.)

NEWS ITEMS

Loyola College, Baltimore, Maryland. Chemistry Department

On October 5th, Dr. Hugh S. Taylor, D.Sc., Director of the Chemical Research Laboratory of Princeton University, lectured to the members of the Loyola Chemists' Club on the subject: ''The Isotopes of Hydrogen.'' The subject was handled with great skill and the latest developments and experiments with ''heavy water'' were announced.

Dr. Alexander O. Gettler, Ph.D., Professor of Chemistry of New York University, Professor of Toxicology at Bellevue Medical School and Toxicologist of New York City, gave a most instructive and interesting lecture on the application of Micro Analysis, to the Chemists' Club, on October 23rd. The subject was: ''Chemistry in the Detection of Crime.''

Another non-resident lecturer was the guest of the Loyola Chemists' Club on November 13th: Dr. M. X. Sullivan, M.D., from the Chemico-Medical Research Laboratory of the Georgetown Medical School. His topic was: ''Chemical Research in Health and Disease.''

Boston College. Physics Department

There are nine students in the Post-Graduate Course. Rev. John Tobin and Dr. Zager are directing these students.

The West Laboratory on the second floor of the Science Building has been equipt for research work in Electronics.

There are three hundred and eighty students in the undergraduate school taking the various courses in Physics. There are more than one hundred in the fourth year B.S. course. The text-books for the senior class are: ''Physical Optics'', by Robertson, and ''Principles of Electrical Engineering'', by Timbie and Bush (new edition). The text-book for the A.B. students is: ''College Physics'', by Foley.

Santa Clara College, Santa Clara, California
Geology Department

Report from False Pass, Alaska.—

Discovery of a new inactive crater even larger than the famous Aniakchak near the tip of the Alaskan peninsula was reported by Father Bernard R. Hubbard, the ''glacier priest,'' after a month of hardships and adventure.

Unprecedented floods, encounters with giant Pavlof brown bears, separation and near disaster befell the expedition in the unexplored region between Pavlof volcano and the tip of the Alaskan paninsula.

"The party left its base camp here on June 22 for the fantastic Aghileen Pinnacles, a group of weird and needle like peaks visible from the sea coast but hitherto unexplored and unclimbed," Father Hubbard said. "The pinnacles constitute one of the unnamed wonders of the world."

Carrying heavy packs of scientific, camping, and photographic equipment, the party trekked through virgin country, over mountain ridges, fording unknown rivers and lakes, until it established its final camp at the base of the Aghileen Pinnacles.

Good weather which marked the trek inland deserted the expedition as it prepared for the climb. For eleven days torrential rainstorms flooded the entire country, marrooning the party and exhausting the food supply. Eighteen inches of rain fell in three days.

During a break in the storm, Father Hubbard, Kenneth Chisholm, his younger brother, Douglas, and Edgar Levin, the priest's assistants from Santa Clara University, attempted to fight their way back to the coast for supplies.

Levin and Kenneth Chisholm, both carrying 100-pound packs, narrowly escaped death when swept off their feet in attempting to cross a swollen stream. The raging torrent pulled Chisholm to the bottom in deep water twice as he struggled with his pack before Levin's 230 pounds of braun could help him to his feet on a jutting sand bar. They reached the coast safely.

Father Hubbard, unwilling to endanger the youngest and least experienced member of the expedition, Douglas Chisholm, returned through the flooded valley to the mountain camp, wallowing for eight hours through renewed cloudbursts in from a foot to three feet of water.

After the return of Levin and Kenneth Chisholm, the party climbed the Aighleen Pinnacles, a feat regarded as impossible by Alaskan guides. Important specimens and geological data were gathered, as well as a motion-picture record of the climb.

"The most important discovery was a huge blow out and greatly altered crater, another Crater of the Moon," Father Hubbard said. "The Aghileen Pinnacles and other near by mountains being merely radial ridges to the hole in the earth, which I estimate is much larger than Aniakchak Volcano in the center of the Alaska Peninsula.

"The original circumference of this new inactive mass was estimated at close to thirty miles.

"Dozens of brown bears were sighted from the camp at the base of the pinnacles, and on two occasions the giant animals came into our camp during the night to steal meat.

"Edgar Levin, while breaking his way through some alder underbrush, surprised a ten-footer who charged him without warning.

"Quick action with an automatic rifle by Levin and a final vital rifle shot by George Peterson, our Alaskan guide, dropped the infuriated Pavlo monster less than his own length from Levin, who was so entangled in the alders that retreat was impossible."

After a few days at its base camp here, the party expects to continue its explorations.

Shanghai, China

A remarkable apparatus, which is able to measure the intensity of relative gravity with a speed and precision never before achieved, has been invented by Father Lejay, S.J., of the Zikawei Observatory, Shanghai. A paper explaining the invention and the observations made by it throughout the Far East was read recently before the French Academy of Sciences. Father Lejay is the son of a French Admiral, and has been carefully prepared by the Society of Jesus to take his place among the eminent scientists of the Zikawei Observatory, who by their scientific achievements have won such prestige for the Church in China. Father Lejay has just returned to China after investigations in the Dutch East Indies, and in Indochina. He journeyed along the South China coast on the "Haishing", the Chinese Maritime Customs cutter, and established forty new gravimetrical stations.

Rome, Italy

Father Filippo Soccorsi, S.J., was appointed Director of the Vatican Radio Station by His Holiness, the Pope, succeeding Father Giuseppe Gianfranceschi, S.J.